BIOFORCETECH PYROLYSIS PROCESS FOR SEWAGE SLUDGE

Letter for US EPA

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BIOFORCETECH Corporation

BIOFORCETECH Corporation
1400 Radio Road, Redwood City, CA, 94065 - USA, +1 (650) 906 0695 - +1 (650) 906 0193
info@bioforcetech.com - **www.bioforcetech.com**

About this document

Bioforcetech Corporation (BFT) is currently requesting, to the Bay Area Air Quality Management District (BAAQMD), a permit to construct and to operate a new technology introduced by Bioforcetech: A Pyrolysis system for sewage sludge biosolids. This system has been studied by BFT for more than 3 years, and now, in collaboration with an european manufacturer, is ready to be built at full scale.
In October 2015, BFT signed a contract with SVWC (Silicon Valley Clean Water). With this contract, BFT is now responsible to design, build and operate a biosolids to energy facility that will treat 7000 tons of biosolids inside the wastewater treatment plant.
The key advantages of this technology are:

1) The process is energy positive from dewatered sludge (80% moisture content)
2) Truck transportation is reduced by 90% (about 190,000 miles saved)
3) From waste (biosolids) to biochar, a nutrient rich sellable soil amendment
4) Compact design: The plant uses about 90% less space than conventional drying beds

During the permit process, the air district (BAAQMD) has come to the "conclusion" that the Bioforcetech pyrolysis reactor has to meet the requirements described into the Title 40 of the code of Federal Regulation, Part 60, subpart LLLL, although the air district is uncertain on this conclusion and has asked BFT to contact USEPA to open a discussion on the process. The goal of this discussion is to identify better procedure and emission limits that will better fit this pyrolysis process

This document wants to also explain the BFT sewage sludge pyrolysis technology to the USEPA.
The document points out the differences between pyrolysis and incineration definitions, differences between pyrolysis and incineration reactors, and the incompatibilities between some parts of the subpart LLLL and the BFT pyrolysis process.

Bioforcetech wants to start a conversation with USEPA about the pyrolysis of sewage sludge, from the moment that the technology developed doesn't fully comply with the definition and the characteristics of the incineration as described in the subpart LLLL.

Please feel free to contact us anytime:

Dario Presezzi, CEO
(650)9060695

d.presezzi@bioforcetech.com

Bioforcetech Pyrolysis process

Pyrolysis

Pyrolysis can be defined as the thermal decomposition of organic material through the application of heat without the addition of air or oxygen. Through this process that takes place at temperatures between 350 and 900 degrees C, 3 co-products are obtained: syngas, bio-oil and char. The percentage of these products depends on the pyrolysis conditions (mainly from temperature and residual time) and from feedstock material.

Why pyrolysis of biosolids

After a careful study of the various available technologies, BFT chose pyrolysis as the biosolids energy recovery system. In the past, many technologies have been used (often unsuccessfully), such as gasification and incineration. From a process management point of view, **pyrolysis guaranteed a higher efficiency, reliability and design simplicity**. Many studies also remarked this technology as the most **environmentally friendly** one, since emissions, especially of heavy metals, are much lower. Furthermore, one of the major problems that arises when using gasification or incineration of biosolids is by-product management. Due to high temperatures, these by-products have a consistency that is hard to manage and often requires particular treatments before being disposed of.
However, **with low pyrolysis temperatures, these by-products are easier to manage** and because of their particular composition, they **can be used in various applications, and can become reusable and sellable.**

BFT has designed a pyrolysis reactor to achieve the maximum production of gaseous material. The gas is immediately burnt (with a **flameless burner**) at the reactor outlet and used for electrical and thermal **energy production**. Although it has been developed for biosolids treatment, **the BFT pyrolysis reactor is able to treat a variety of biomasses** such as green waste, manure and agricultural waste.

The process and the machinery : Pyreg®

The BFT system uses the double screw pyro-reactor for heating and carbonising of the feedstock. The feedstock, loaded into a truncated shaped enclosed hopper bin external to the shipping container, is transferred from the feeder bin, which has a level control monitor, via a horizontal, torque controlled screw conveyor and metering device, to the pyro-reactors. Two motor-driven rotary valves ensure anaerobic supply of fuel, providing fire back protection. The rate of distribution is from **200 kg/hr to 240 kg/hr**, or up to 1,800 metric tonnes of feedstock per year. During the conveying process through the pyro-reactor, the feedstock is subjected to **thermal degradation between 450° C to 800° C for 15 to 30 minutes.** Inside the central column of the pyro-reactor there are two contra-rotating, interlocked, helical screws driven by a geared motor unit.

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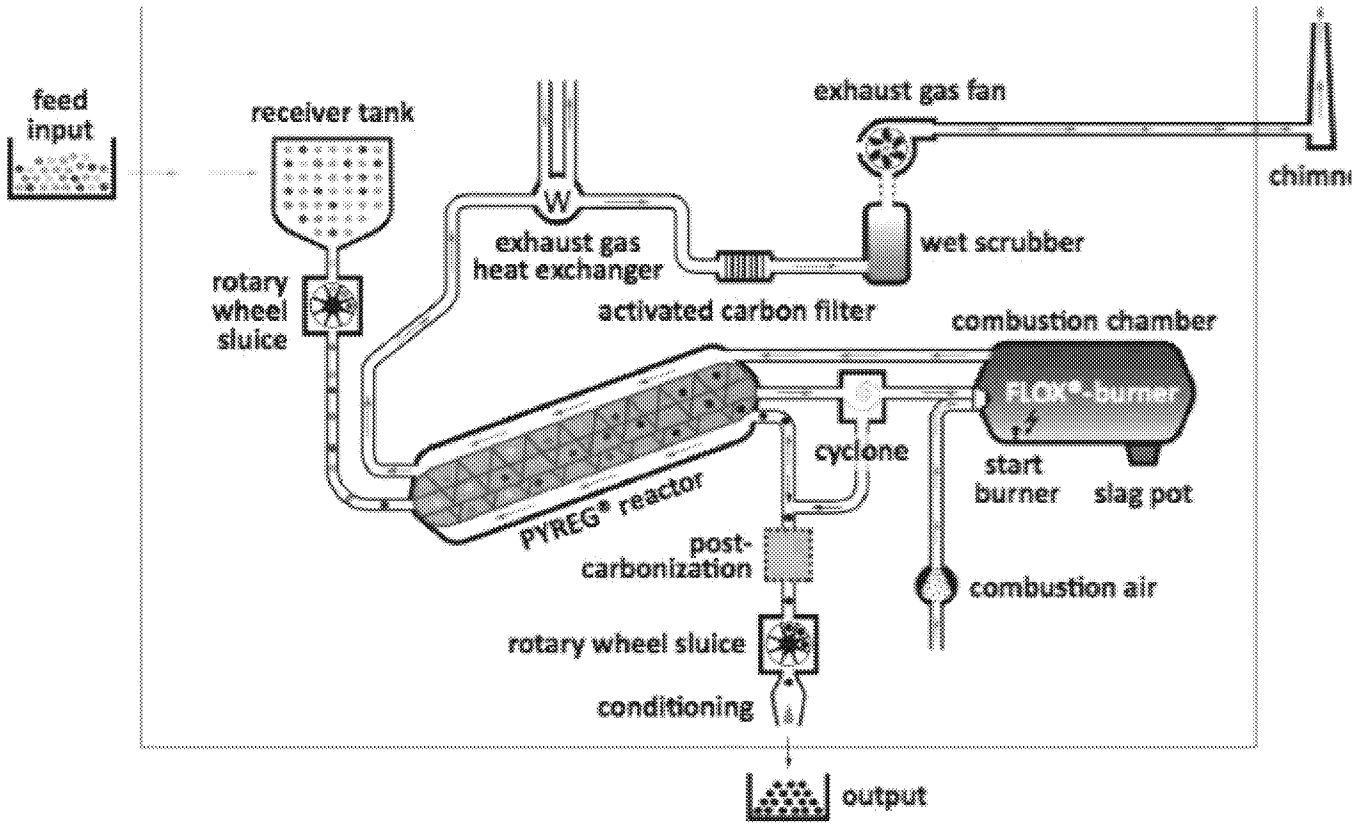
The risk of flammable **gases escaping from the plant is avoided** because the continuous process conditions are maintained at a small negative pressure (differential pressure to atmosphere 0.5-1.5 mbar) by induced draft fans that operate on a duty-standby basis together with a **battery backup system to automatically shut down the process in case of mains electrical failure**.

To prepare the **process to become self-perpetuating**, the combustion chamber needs to be fired, initially, by a supply of gas from an LPG tank or natural gas mains. Normally this start-up period takes approximately 45 minutes. After the start-up, syngas and volatile components are produced while the feedstock travels through the pyro-reactors. These products are transferred, through pipes, to the adjacent **combustion chamber where they are mixed with air and burnt in a flameless burner (FLOX®)** at about 1,250° C .

The exhaust gases from the combustion chamber are then passed through the annular space formed between the central tube and the outer casing of the pyro-reactor, ensuring the temperatures required to perpetuate the pyrolysis process.
Each pyro-reactor is inclined at about 25 degrees to the horizontal with the heated emissions flowing top downwards. **The exhaust gases from the pyro-reactor pass through a heat exchange system**, via a cyclone (to remove dust particles) ,enter the exhaust cleaning system (activated carbon filter + wet scrubber) and exit the chimney stack.

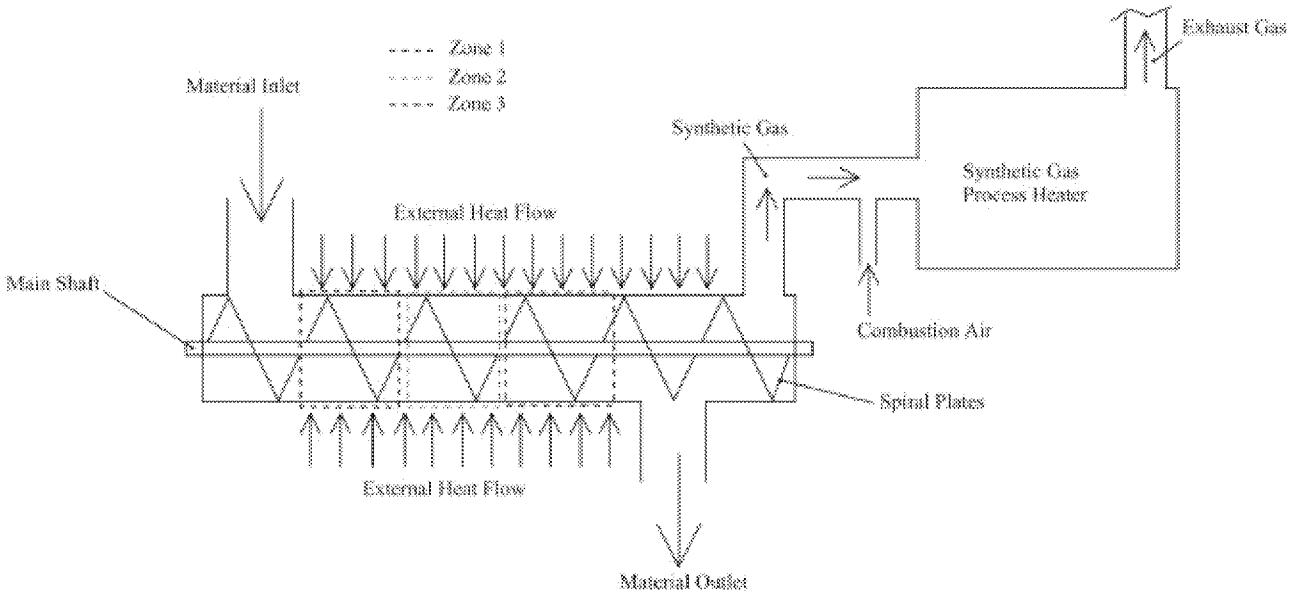


BioForceTech (BFT) pyrolysis process treat the biosolids without have any combustion reaction inside at the reactor itself.

1. The material is loaded from the top-left.
2. The material is than pushed through different reaction sections using elicoidal plates connected to a main central shaft.In these sections, an heated flow is applied on the external surface of the reactor; so there is no direct contact between the material and the heating source.
3. Finally the material unloaded from the bottom-right.

During the process the material go through three different reaction zone:

- Zone 1 or evaporating zone. All the water inside the biosolids is removed
- Zone 2 or light gas formation. The first fraction of the biosolids is volatilized creating methane, hydrogen and light hydrocarbon compound.
- Zone 3 or heavy gas formation. The last part of the biosolids is volatilized creating light and heavier hydrocarbon compound.



1.1 - Schematic representation of BFT Pyrolysis process

For further informations about the machinery, please see the technical sheet attached to this document.

EPA 40 CFR Part 60, Subpart LLLL

Definitions

Sewage Sludge Incineration p.15376
"A SSI unit is an enclosed device or devices using controlled flame combustion that burns sewage sludge for the purpose of reducing the volume of the sewage sludge by removing combustible matter."

Multiple Hearth Incinerator pp. 15422 - 15423
"Multiple hearth incinerator means a circular steel furnace that contains a number of solid refractory hearths and a central rotating shaft; rabble arms that are designed to slowly rake the sludge on the hearth are attached to the rotating shaft. Dewatered sludge enters at the top and proceeds downward through the furnace from hearth to hearth, pushed along by the rabble arms."

Fluidized Bed Incinerator p.15422
"Fluidized bed incinerator means an enclosed device in which organic matter and inorganic matter in sewage sludge are combusted in a bed of particles suspended in the combustion chamber gas."

Definition of pyrolysis by Stephen Rothblatt, at the time Chief Air Programs Branch Indiana (2000)
http://yosemite.epa.gov/r5/r5ard.nsf/2134f82000aa062c86257577004df4d7/7ea207b44e70abab862574c8006e223c!OpenDocument

"Pyrolysis technology is different from conventional incineration. Because air is generally not used in the pyrolysis treatment process, the volume of exhaust gas produced from pyrolysis treatment is likely to be far less than the volume of gas produced from the burning of waste in an HMIWI. Although conventional combustion does not occur during pyrolysis treatment, there are some emissions from the pyrolysis process[...].
There are a number of noteworthy, additional differences between pyrolysis technology and conventional incineration. First pyrolysis technology is an endothermic reaction (absorbs heat) while combustion is an exothermic reaction (releases heat).
Second, pyrolysis occurs in the presence of an insignificant amount of oxygen. Third and finally, pyrolysis has an external energy source."

In the case reported above the discussion was about the incineration of Hospital/Medical/Infectious Waste Incinerators (HMIWI). In every case a clear definition of pyrolysis is provided.

Incompatibilities with the Bioforcetech pyrolysis system

Definition of incineration

The definition of SSI in this subpart says : "A SSI unit is an enclosed device or devices using controlled flame combustion that burns sewage sludge for the purpose of reducing the volume". In the Bioforcetech pyrolysis process no flame combustion is used to burn the sewage sludge. The solid material is only heated at a low temperature in an oxygen free environment, and the purpose is only to generate a syngas. The flameless combustion takes place only on the syngas and only into a separate chamber dedicated to the gas oxidation.

Operator Training and Qualification: 60.4810

The BFT pyrolysis unit is very small (max 0.25 ton/h for 7500 hours/y), the system is fully automated and our team is the highest expert on the bioforcetech pyrolysis machinery.
We also have noticed that the training requirement are specific for the management of an incineration reactor, making this qualification not fully suitable to the pyrolysis process.

Emission Limits, Emission Standards, and Operating Limits and Requirements : 60.4845

In this section of the subpart the emission limits are specified in table 1 and 2. In these two tables the emission limits are specific for two different type of sewage sludge Incinerators:

- Multiple Hearth Incinerator
- Fluidized Bed

Nither one of these two types of incinerators are comparable with the BFT sewage sludge pyrolysis reactor.
http://www3.epa.gov/ttnchie1/ap42/ch02/final/c02s02.pdf
We try to compare our technology with the Fluidized Bed (FB), and the Multiple Hearts (MH) incineration machinery, and we believe that our technology, if we have to find similarities, is more similar to a MH incinerators.

Why is not a FB:
- BFT process does not have any fluid bed of particles suspended in the combustion chamber gas.
- In the BFT reactor, no external gas is being blown from the bottom to the top.

What are the similarities to the MH:
- The material is loaded from the top
- BFT reactor has multiple plates that push the material through different reaction zones (similar to the hearts). Those plates are connected to a main shaft that provide the rotary movement (like the MH).
- The material is discharged from bottom right side